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Iris Recognition using Mel-Fequency Cepstral Coefficient

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Abstract--- ***This paper proposes Iris feature extraction using Mel Frequency Cepstral Coefficient (MFCC). MFCC is originally used for speech and speaker recognition. The MFCC is applied in Iris recognition and the results obtained are very accurate and satisfactory. The system first takes the eye pattern of a person and after converting to 1D signal the MFCC is applied which extracts Iris features. The features are then compared with the features obtained in Enrollment phase, and decision is made after taking Euclidean distance.***

Keywords—Iris, recognition, recognition system, MFCC, Mel- Fequency Ceptral Coefficient.

I. INTRODUCTION

In today's world, biometric authentication is very popular and widely used. It is easy way to identify or verify a person's identity. Biometric authentication is recognition of a person through fingerprint, palm print, face structure, voice features and retina patterns, in other words, recognition of a person by his exposed body parts is known as biometric authentication. In this paper work is done on Iris recognition using Mel-Frequency Cepstral Coefficient. There are many algorithm and techniques developed for Iris recognition. The wavelet analysis is very decisive and many algorithms are based on it like algorithm proposed by Nabti and Bouridan, based on wavelet maxima and a special Gabor filter bank, algorithm by Narote et al. based on the Dual Tree Complex Wavelet Transform[i]. Here Mel- Frequency Cepstral Coefficient is used for Iris Recognition which is commonly used for speech and speaker recognition. MFCC extracts features from a given image. In case of voice recognition, it extract features by the steps as follows: first the 1D signal is divided into small segments or frames to make its statistical parameter constant, windowing suppress frequencies at edges and boost up its center frequencies, FFT converts the signal to frequency domain, Mel-Scale gives the distance between each filter and also size of each filter, log do normalization and after taking DCT, we get MFCC coefficients. The MFCC coefficients of database sample and the MFCC coefficients of testing samples are matched to identify or verify a person. In case of Iris recognition, first the image signal, which is a 2D image, has to be converted into 1D signal and then is given to MFCC as input 1D signal to extract feature likewise a voice signal. Iris recognition is mainly consist of two phases; first phase is to extract the features from an image and make a database, known as training phase and second phase; to extract and match features from a testing sample with the samples present in database, known as testing phase. Feature extraction and conversion is common in both phases.

II. IRIS RECOGNITION METHODOLOGY

The idea proposed in this paper is to extract features for Iris recognition by using MFCC. The process of recognition follows the steps shown in fig. 1. It can be divided into two phases, training phase and testing phase. The two main steps which are common in training and testing phase are; first step is the conversion of image signal, which is 2D signal, to 1D signal. Second step is the extraction of features. In training phase, the 2D image is converted into 1D signal then using MFCC features are extracted and stored in database. In testing phase, same procedure is repeated, image is converted to 1D signal and features are extracted. The difference is that the extracted feature in testing phase is matched with the sample features in database which were saved in database in the training phase. The conversion of image signal to 1D is very important because here the algorithm for recognition used is MFCC and MFCC only works on 1D signal. After conversion, the 1D signal is given to MFCC as input signal which extracts features from it smoothly.

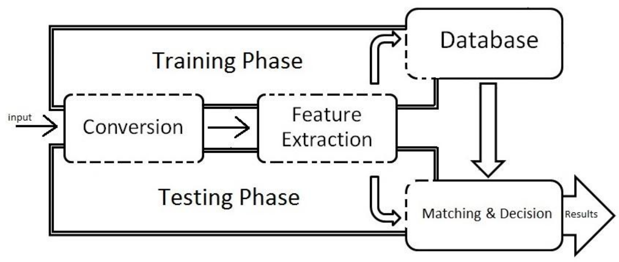

Fig.1 Iris Recognition System

Feature extraction is very important for recognition. Basically in feature extraction only the useful data is selected which compresses the signal and the unwanted data is discarded. MFCC is mostly known for feature extraction from a speech signal but researches showed that it can be used for face recognition[ii], gesture recognition[iii], palm print recognition[iv] and satellite image recognition[v].

Steps for applying MFCC in Iris recognition is same as steps in voice recognition except that in Iris recognition the 2D

image signal is converted into 1D signal as MFCC works on 1D signal, the rest of steps are same. Feature extraction using MFCC consist of following steps shown in fig. 2

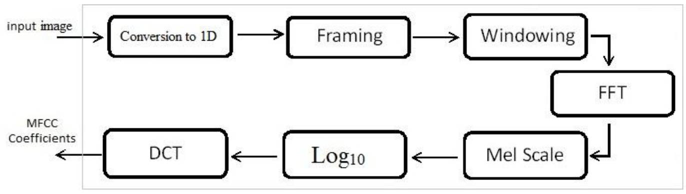

Fig. 2 MFCC step for extraction coefficients.

A) Conversion to 1D

The first step for feature extraction by MFCC in Iris Recognition is that to convert the 2D iris image to 1D image signal. The conversion to 1D is necessary because MFCC works better on 1D signal.

B) Framing

Framing is the segmentation of signal into small frames. Frame size varies from 20 to 30ms with 50 to 60% of overlapping. If we have 24 kHz signal and frame size is 25ms with 50% overlapping then number of samples per frame are 600 with overlapping of 300 samples. Framing also provides stationary signal as it is changing constantly on short time scale[vi]. The sample rate per frame should be selected carefully as if the frame size is too large there may be a sudden change in the samples and if it is too small, it may not contain useful information for spectrum calculation. The samples per frame can be given as:

$$N = Fs * T \tag{1}$$

Where N is number of frames, Fs is sampling frequency and T is time per frame.

C) Windowing

In windowing each frame is passed through window to make its irregular edges i-e at starting and ending [vii], continue. It also boosts up frame frequencies in center which contain more information and smoothen the high variations in the start and end of frame. Normally a Hamming or Hanning window is used. In this process each frame is multiplied with window function, the output after each windowing is.

$$Y(m) = X(m)*W_n(m),\ 0 \le m \le N_m -1 \tag{2}$$

Where X(m) is the input signal coming from framing, N_m is the number of sample in each frame and $W_n(m)$ is hamming window represented as.

$$W_n(m) = 0.54 - 0.46\ Cos\ (2\pi m/(N_m -1)),0 \le m \le N_m -1 \tag{3}$$

D) Fast Fourier Transform (FFT)

To convert a signal from time domain to frequency domain is done by using FFT[viii]. It is taken out to see the magnitude response of signal as the energy is distributed over frequencies present in the signal. Normally DFT or FFT are used but here FFT has been used due to its fast and easy computational speed. Basically FFT and DFT give same results but the difference is that FFT divides the signal into small frames and then perform transformation on each frame separately while DFT takes transformation of the whole signal.

E) Mel Scale

Mel scale gives us approximation about the energy present in the spectrum. Triangular filter bank is used for the calculation of energy at each point. These filters are band pass filters with spacing given by the Mel scale. The Mel- scale is given by eq. 5. The Mel scale is between pitch and frequency which shows that the relation between pitch and frequency is linear till 1 kHz and logarithmic after 1 kHz as shown in fig. 3. This scale helps in the designing of filter. It tells how much wide the filter should be and how much spacing should be kept between each filter. This filter bank is also known as Mel filter bank or Mel Bank as shown in fig. 4. The formula which is used for the conversion of frequency "f" to mel "m_f" is given by below eq. 5

$$m_f= 2594log_{10}(f/700+1) \tag{4}$$

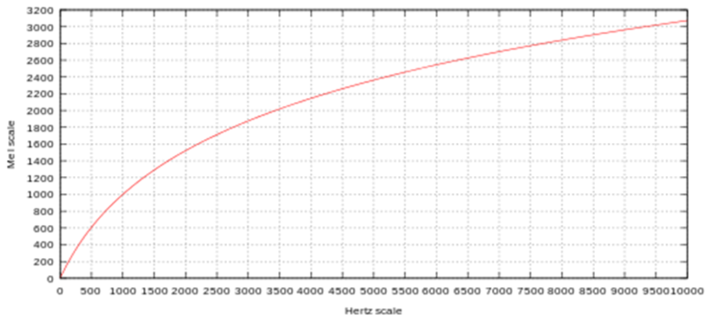

Fig. 3 Mel- Scale

In Mel filter bank, the size and space between filters is decided by frequencies in Mel scale. As fig. 4 shows that the filters till 1kHz has less spaced between each other because the frequency from Mel scale is smaller and as the frequency get higher the space between filters increase and get wider and wider. The proper spaced filters give us the energy present in the signal at each point.

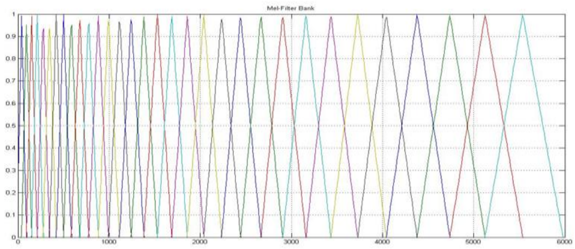

Fig.4 Mel- Bank

F) Logarithm

Log of base 10 is applied on each output spectrum from Mel bank before applying DCT for normalization that is to makes small values large enough and large value small enough for DCT calculation.

G) Discrete Cosine Transform (DCT)

DCT is performed to covert a signal i-e log Mel spectrum back to time domain. It also gives coefficients of log Mel spectrum and also compresses it. DCT convert the finite sequence of data points to a sum of cosine functions oscillating at different frequencies [ix]. Here we are using DCT instead of DFT because DCT is use in lossy data compression.

An overview of all steps for Iris Recognition can be summarized as: the image is first converted from 2D to 1D image. Then the converted image signal is segmented into small frames about 20 to 30 ms with 50 to 60% of overlapping. After framing, windowing suppress the high frequencies at edges. Then the signal is converted to frequency domain by FFT. Mel- scale provides the size and distance between each filter and filters the signal using Mel- Bank. After taking log of output from Mel- Bank, DCT gives the final Mel- Frequency Cepstral Coefficients.

III. EXPERIMENTAL RESULTS

From the background of MFCC we know that this technique is used in different recognition pattern like voice, palm print, and face recognition and it yields best result so here MFCC is used and applied in Iris recognition. For experiment first we kept 10 different iris patterns in database. Five of them are shown in fig. 5 and are discussed as follow.

Fig. 5 Iris Samples

We took five iris samples of five different persons and during the enrollment phase the features are extracted using MFCC and stored in database. In testing phase the iris pattern of same person at different time is given as input image as shown fig. 6. The right side shows the samples which we took as input and the left side shows the samples which are placed in database. The input image of iris which is a 2D image is first converted into 1D image signal and then is passes through the steps used for calculation of MFCC, which are explained in section II. As in the feature extraction process, the MFCC extracted coefficients from the sample given to MFCC as testing sample, after features extraction both coefficients of database's sample and testing sample are matched. The plots in fig.6 are the coefficients of each of sample and testing sample respectively.

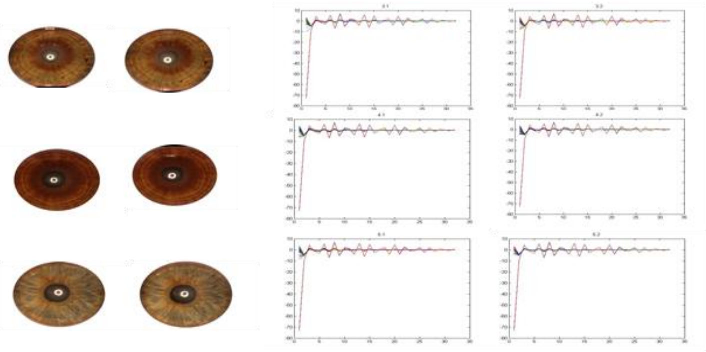

Fig. 6 MFCC Coefficients

On basis of Euclidian distance, decision is made. The Euclidian distance difference between each sample and testing sample is given in table. 1. The test was carried out multiple times, taken different samples at different instant and the result we got was very accurate and satisfactory.

In table.1 Iris A' to Iris E' shows the test taken out for each sample with sample iris at different time. The Iris A to Iris E shows the sample pattern which were kept in database as samples. The results got from Euclidian distance are quite satisfactory shown in Table 1.

Table.1 Euclidian Distance difference

------	Iris A'	Iris B'	Iris C'	Iris D'	Iris E'
Iris A	0.0427	0.7459	0.6459	0.5410	0.9382
Iris B	0.9619	0.0377	0.8506	0.7558	0.5503
Iris C	0.3552	0.2647	0.0570	0.6439	0.8502
Iris D	0.8628	0.5544	0.3410	0.0382	0.6445
Iris E	0.5270	0.3473	0.8417	0.5407	0.0399

IV. FUTURE WORK

In this paper we used Mel frequency cepstral coefficient for Iris recognition. However MFCC is very sensitive to Noise Interference, which results in mismatch between training and testing samples. In order to improve the performance of MFCC in the extraction of Iris features, we have to introduce some noise cancellation mechanism, which will even further improve the results.

V. CONCLUSION

In this paper we presented the use of MFCC in iris recognition to get robust result. First the iris image is converted from 2D image to 1D image and is given to MFCC for feature extraction. MFCC coefficients are used in testing phase for comparison with the coefficients from the training phase sample. The Euclidian Distance of test sample is calculated with all training samples and the decision is made on this basis minimum distance. If the distance is less than the threshold defined then the samples is taken as matched otherwise the samples are not matched.

In recent years, most of the research is done on the use of MFCC in voice recognition with robust results. Application of MFCC in Iris Recognition is very accurate and satisfactory.

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